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COST OPTIMIZATION OF RC GODOWN

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ABSTRACT

In the present scenario the whole world is in the state of race to earn maximum profit. In this thesis the present work deals with the aim of achieving optimal design of reinforced concrete structures , optimal sizing and reinforcing for beam and column members in multi bay and multi storey structures results in cost saving over typical practice design . For a column free space of 7.5m wide optimal spacing of beams and columns for all three live load intensities that is 3 KN/m^2,4 KN/m^2 and 5 KN/m^2 respectively is 2m.Spacing of 2m, 3m and 5m is taken with span of 30m including 32m span of 4m spacing. Though the cost of structure with spacing of beam less than 2m has not been worked out but it is thought that it will increase the cost as compared to cost of structure with 2m spacing, because it will increase in number of beams, columns and footings without appreciable decrease in the cost of slab.

Key words: reinforced concrete, beams, columns, footings, slab and cost.

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1. INTRODUCTION

Being a multi-dimensional problem, the structural optimization need proper care without leaving single scope of error. Selection of material and type of structure are decided at very initial stage. Sometime the design structure turns out to be uneconomical due to various constraints and limitation. So to avoid such condition there should be use of proper constructional material and proper proportioning of elements of structure with suitable configuration of structure. It is the process in which an objective function is maximum or

minimum cost of the project. In engineering safety and cost are taken into account. Structural optimization is a multidimensional problem. At the very initial stage one has to decide about the type of structure and the material for its construction, depending upon the technical knowledge and facility available for its execution.

One may have to optimize a structure which may otherwise be uneconomical due to various constraints and limitations. Once the type of structure is decided problem reduces to minimizing cost/weight of structure.

a) By selecting proper construction material.

b) Proper proportioning of the elements of the structure and assuming suitable configuration of structure

2. METHODOLOGY

The following design philosophies have been evolved for the design of RC structures

2.1. Working Stress Method (WSM)

The structural material behaves as a linear elastic manner, and that adequate safety can be ensured by suitably restricting the stresses in the material induced by the expected "working loads" on the structure.

2.2. Limit State Method (LSM)

It is advantageous to use methods of design that have proved safe in the past. Standardised design methods can help in comparing alternative designs while minimising the risk of the cheapest design being less safe than the others. The regulations and guidelines to be followed in design are given in the Codes of Practices which help in ensuring the safety of structures.

3. RESULT AND ANALYSIS

Centre to Centre spacing of columns 2 m c/c	**Volume of concrete in slab**	**Volume of concrete in beam No. of beam=16**	**Volume of concrete in column No. of column=32**	**Volume of concrete in footing No. of footing=32**	**Total volume of concrete**	**Cost of concrete (A)**	**Total Cost (A+B)**
D.L.=3.5KN/M, 5.25 KN/M L.L= 3 KN/M, 4.5 KN/M M = (5.25/10 + 4.5/9) 2.5^2 M = 6.4 KNM	22.5 m^3 D=100mm	23.26 m^3 (300mm x 500mm)	9.22 m^3 (300mm x 300mm)	84.64 m^3 (2.3m x 2.3m) D=500 mm	139.62 m^3	Rs.928130	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	1038 kg 8mm@210 c/c	1959 kg 4#20mm	852kg 4#16mm Lateral ties 5#@192 c/c	1002kg 16mm@230 c/c	4851 kg	Rs.329868	Rs.1257998
Centre to Centre Spacing of Columns 3.0m c/c	Volume of Concrete in Slab	Volume of Concrete in Beam No. of beam=11	Volume of concrete in Column No. of column=22	Volume in concrete in footing No. of footing=22	Total volume of concrete	Cost of concrete (A)	Total Cost (A+B)
D.L.=3.5KN/M, 5.25 KN/M L.L= 30 KN/M, 4.5 KN/M M = (5.25/10 + 4.5/9) 9 M = 9.225 KNM	22.5 m^3 D=100mm	17.1 m^3 (300mm x 600mm)	6.33 m^3 (300mm x 300mm)	83 m^3 (2.5m x 2.5m) D=600 mm	128.43 m^3	Rs.853744	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	1375 kg 8mm@140 c/c 8mm@120 c/c	2053 kg 6#20mm	586 kg 6#12mm, Lateral ties 5mm@192 c/c	872 kg 12mm@200 c/c	4886 kg	Rs.332248	Rs.1185992

Table 1 Live Load 3KN/M

Centre to Centre spacing of columns 5m c/c	Volume of concrete in slab	Volume of concrete in beam No. of beam=7	Volume of concrete in column No. of column=14	Volume of concrete in footing No. of footing=14	Total volume of concrete	Cost of concrete (A)	Total Cost (A+B)
D.L.=3.75KN/M, 5.625 KN/M L.L= 3 KN/M, 4.5 KN/M M = (5.625/10 + 4.5/9) 3.75^2 M = 14.94 KNM	24.75 m^3 D=110mm	11.59 m^3 (300mm x 500mm)	5.49 m^3 (350mm x 350mm) (H=3200 mm)	65.86 m^3 (2.8m x 2.8m) D=600 mm	107.69 m^3	Rs.715874	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	1580 kg 10mm@200 c/c 6mm@120 c/c	1917 kg 4#20mm	373 kg 4#16mm Lateral ties 8mm@192 c/c	1052 kg 16mm@150 c/c	4922kg	Rs. 334696	Rs. 1050570

Table 2 Live Load 4 kn/M

Centre to Centre spacing of columns 4 m c/c	Volume of concrete in slab	Volume of concrete in beam No. of beam=9	Volume of concrete in column No. of column=18	Volume of concrete in footing No. of footing=18	Total volume of concrete	Cost of concrete (A)	Total Cost (A+B)
D.L.=3.5KN/M, 5.625 KN/M L.L= 3 KN/M, 4.5 KN/M M = (5.625/10 + 4.5/9) 3.75^2 M = 14.94 KNM	24.75 m^3 D=110mm	14.9 m^3 (300mm x 500mm)	7.056 m^3 (350mm x 350mm)	85.3 m^3 (2.8m x 2.8m) D=600 mm	142 m^3	Rs.943951.54	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	1580 kg 10#@200 c/c φ6@120 c/c	1917 kg 4#20mm	479 kg 4#16mm Lateral ties 5mm@192 c/c	1052 kg 16#@150 c/c	5028kg	Rs. 341904	Rs. 1285855.5

Centre to Centre spacing of columns 2 m c/c	Volume of concrete in slab	Volume of concrete in beam No. of beam=16	Volume of concrete in column No. of column=32	Volume of concrete in footing No. of footing=32	Total volume of concrete	Cost of concrete (A)	Total Cost (A+B)
D.L.=3.5KN/M, 5.25 KN/M L.L= 4 KN/M, 6 KN/M M = (5.25/10 + 6/9) 2.5^2 M = 7.44 KNM	22.5 m^3 D=100mm	28.63 m^3 (300mm x 500mm)	9.22 m^3 (300mm x 300mm)	100m^3 (2.5m x 2.5m) D=500 mm	160.35 m^3	Rs. 1065933	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	1150 kg 8mm@180 c/c	1882 kg 5#20mm	851 kg 4#16mm Lateral ties 5mm@192 c/c	1078 kg 16mm@190 c/c	4961 kg	Rs. 337348	Rs. 1403281
Centre to Centre Spacing of Columns 3.0m c/c	Volume of Concrete in Slab	Volume of Concrete in Beam No. of beam=11	Volume of concrete in Column No. of column=22	Volume in concrete in footing No. of footing=22	Total volume of concrete	Cost of concrete (A)	Total Cost (A+B)
D.L.=3.5KN/M, 5.25 KN/M L.L= 4 KN/M, 6 KN/M	22.5 m^3 D=100mm	17.1 m^3 (300mm x 600mm)	6.33 m^3 (300mm x 300mm)	96.8 m^3 (2.7m x 2.7m) D=600 mm	142.73 m^3	Rs. 948803	
	wt. of steel in	wt. of steel	wt. of steel in	wt of steel in	total wt of	Cost of	

M = (5.25/10 + 6/9) 9 M = 10.725 KNM	slab	in beam	column	footing	steel	steel (B)	
	1546 kg 8mm@120 c/c 6mm@120 c/c	2097 kg 6#20mm	585 kg 6#16mm Lateral ties 5mm@192 c/c	1066kg 16mm@180 c/c	5293 kg	Rs. 359924	Rs. 1308727

Centre to Centre spacing of columns 4 m c/c	**Volume of concrete in slab**	**Volume of concrete in beam No. of beam=9**	**Volume of concrete in column No. of column =18**	**Volume of concrete in footing No. of footing=18**	**Total volume of concrete**	**Cost of concrete (A)**	**Total Cost (A+B)**
D.L.=3.5KN/M, 5.625 KN/M L.L= 4 KN/M, 6 KN/M M = (5.625/10 + 6/9) 3.75^2 M = 17.28 KNM	24.75 m^3 D=110mm	14.9 m^3 (300mm x 500mm)	7.056 m^3 (350mm x 350mm)	97.9 m^3 (3m x 3m) D=600 mm	144.6 m^3	Rs.961234	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	1846 kg 10#@160 c/c 6#@120 c/c	2414kg 4#20mm	450kg 4#16mm Lateral ties 5#@192 c/c	1337kg 16#@130 c/c	6047 kg	Rs. 411196	Rs. 1372430

Centre to Centre spacing of columns 5 m c/c	**Volume of concrete in slab**	**Volume of concrete in beam No. of beam=7**	**Volume of concrete in column No. of column =14**	**Volume of concrete in footing No. of footing=14**	**Total volume of concrete**	**Cost of concrete (A)**	**Total Cost (A+B)**
D.L.=3.75KN/M, 5.625 KN/M L.L= 4 KN/M, 6 KN/M M = (5.625/10 + 6/9) 3.75^2 M = 17.28 KNM	24.75 m^3 D=110mm	11.59m^3 (300mm x 500mm)	5.49 m^3 (350mm x 350mm)	75.60 m^3 (3m x 3m) D=600 mm	117.43 m^3	Rs. 780621	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	1846 kg 10mm@160 c/c 6mm@120 c/c	2414kg 4mm#20	373kg 4#16mm Lateral ties 5mm@192 c/c	1337kg 16mm@130 c/c	5970kg	Rs. 405960	Rs. 1186581

Table 3 Live Load 5 kn/M

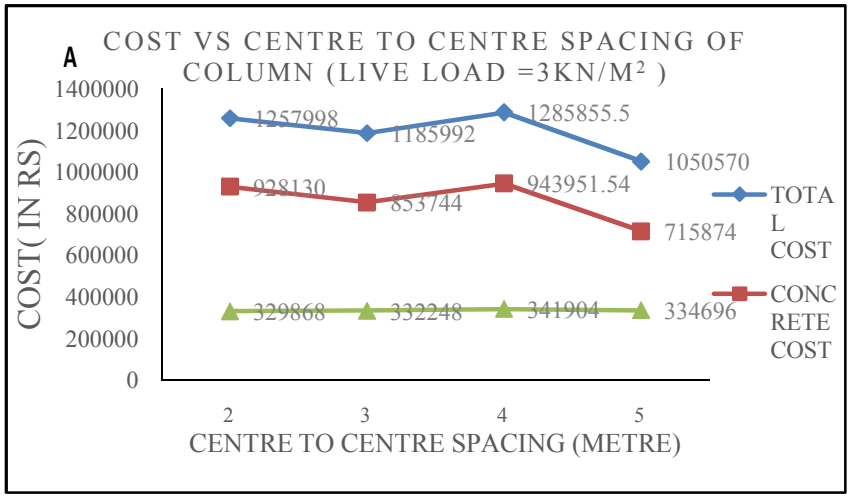
Centre to Centre spacing of columns 2. m c/c	**Volume of concrete in slab**	**Volume of concrete in beam No. of beam=16**	**Volume of concrete in column No. of column=32**	**Volume of concrete in footing No. of footing=32**	**Total volume of concrete**	**Cost of concrete (A)**	**Total Cost (A+B)**
D.L.=3.5 KN/M, 5.25 KN/M L.L= 5 KN/M, 7.5 KN/M M = (5.25/10 + 7.5/9) 2.5^2 M = 8.5 KNM	22.5m3 D=100mm	23.26 m^3 (300mm x 500mm)	9.22 m^3 (300mm x 300mm)	32.00 m^3 (2.6m x 2.6m) D=500 mm	86.98 m^3	Rs. 578203.03	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	1245 kg 8mm@160 c/c	2013 kg 5#20mm	851kg 4#16mm Lateral ties 8mm@192 c/c	1353 kg 16mm@160 c/c	5462.84 kg	Rs. 371473.12	Rs949676.15
Centre to Centre Spacing of Columns 3.0m c/c	Volume of Concrete in Slab	Volume of Concrete in Beam No. of beam=11	Volume of concrete in Column No. of column=22	Volume in concrete in footing No. of footing=22	Total volume of concrete	Cost of concrete (A)	Total Cost (A+B)
D.L.=3.5 KN/M,	22.5 m^3	17.1 m^3	6.76 m^3	104 m^3	150.36 m^3	Rs.	

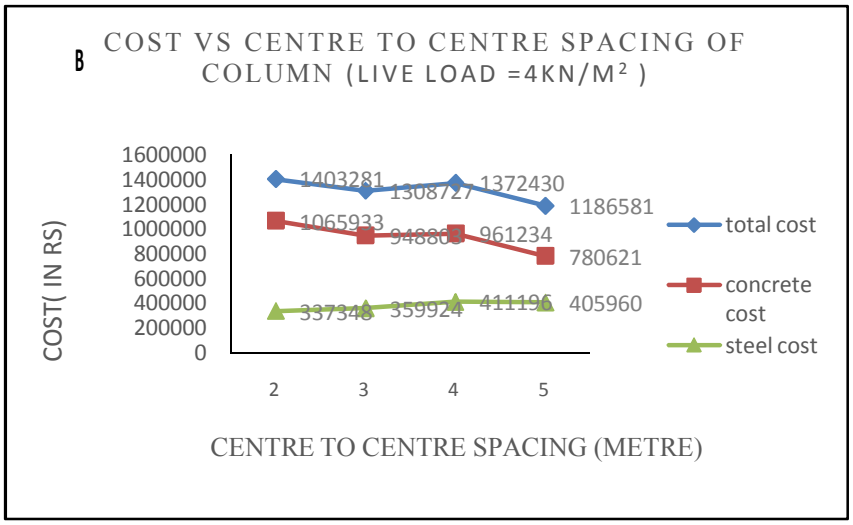
5.25 KN/M L.L= 5 KN/M, 7.5 KN/M M = (5.25/10 + 7.5/9) 9 M = 12.225 KNM	D=100mm	(300mm x 500mm)	(310mm x 310mm)	(2.8m x 2.8m) D=600 mm		999524.11	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	1775 kg 8mm@100 c/c 6mm@120 c/c	2371kg 7#20mm	586 kg 4#16mm Lateral ties 5mm@192 c/c	1265 kg 16mm@160 c/c	5997kg	Rs. 407796	Rs. 1407320.11

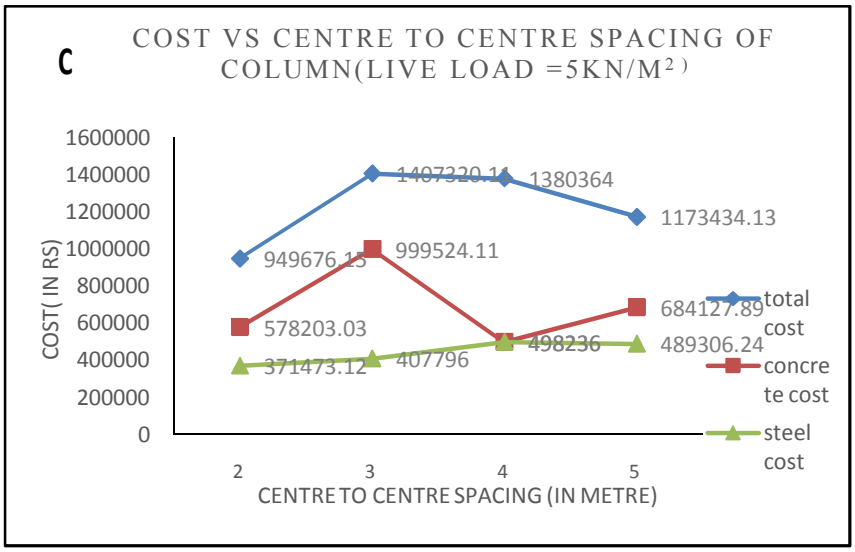
Centre to Centre spacing of columns 4 m c/c	**Volume of concrete in slab**	**Volume of concrete in beam No. of beam=9**	**Volume of concrete in column No. of column =18**	**Volume of concrete in footing No. of footing=18**	**Total volume of concrete**	**Cost of concrete (A)**	**Total Cost (A+B)**
D.L.=3.5 KN/M, 5.625 KN/M L.L= 5 KN/M, 7.5 KN/M M = (5.625/10 + 7.5/9) 3.75^2 M = 19.6 KNM	24.75 m^3 D=110mm	14.9 m^3 (300mm x 500mm)	7.056 m^3 (350mm x 350mm)	88 m^3 (3.2m x 3.2m) D=500 mm	132.7 m^3	Rs. 882128	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	2052 kg 10#@140 c/c 6#@120 c/c	2435 kg 4#20mm	504 kg 4#16mm Lateral ties 5#@192 c/c	2336 kg 16#@120 c/c	7327 kg	Rs. 498236	Rs. 1380364

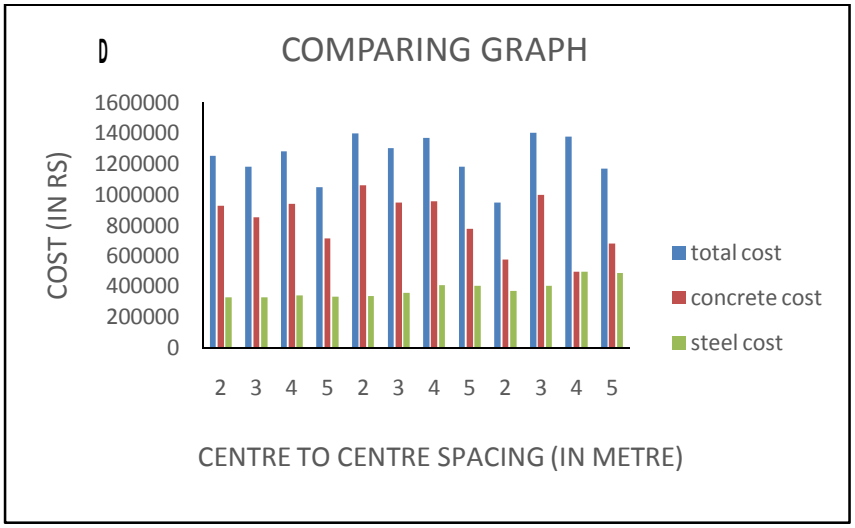
Centre to Centre spacing of columns 5m c/c	**Volume of concrete in slab**	**Volume of concrete in beam No. of beam=7**	**Volume of concrete in column No. of column =14**	**Volume of concrete in footing No. of footing=14**	**Total volume of concrete**	**Cost of concrete (A)**	**Total Cost (A+B)**
D.L.=3.75 KN/M, 5.625 KN/M L.L= 5 KN/M, 7.5 KN/M M = (5.625/10 + 7.5/9) 3.75^2 M = 19.6 KNM	24.75 m^3 D=110mm	4.23 m^3 (300mm x 500mm)	5.49 m^3 (350mm x 350mm)	68.44m^3 (3.2m x 3.2m) D=500 mm	102.91 m^3	Rs. 684127.89	
	wt. of steel in slab	wt. of steel in beam	wt. of steel in column	wt of steel in footing	total wt of steel	Cost of steel (B)	
	2052 kg 10mm@140 c/c 6mm@120 c/c	2435 kg 4#20mm	372.68kg 4#16mm Lateral ties 5mm@192 c/c	2336 kg 16mm@120 c/c	7195.68 kg	Rs. 489306.24	Rs. 1173434.13

Figure A,B,C,D shows variation in cost at different spacing with different loading at column, beam, footing and slab. A graph is plotted in order to compare the same in one graph. Total cost is plotted with blue line, concrete cost is plotted with orange line and silver line denotes steel cost.









4. CONCLUSION

The conclusion derived in the present study is based on the cost of two materials assumed in the study. The cost of concrete that includes (a) cost of material (b) cost of mixing (c) cost of transportation (d) cost of compaction (e) cost of curing and cost of form work, which are different in various components such as slabs, beams, columns and footing. The cost of concrete in all these components has been taken to be the same. The cost of concrete greatly depends upon the size of shuttering available with the contractor. But in the present study a uniform value has been achieved for the cost of concrete of column of various sizes .The conclusions are therefore with these limitations.

The two measure conclusions for the two types of problem considered in the study are as follows:

For a column free space of 7.5m wide optimal spacing of beams and columns for all three live load intensities that is 3 KN/m^2,4 KN/m^2 and 5 KN/m^2 respectively is 2m.Though the cost of structure with spacing of beam less than 2m has not been worked out but it is thought that it will increase the cost as compared to cost of structure with 2m spacing, because it will increase in number of beams, columns, footings without appreciable decrease in the cost of slab.

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